UNITED NATIONS TECHNICAL PROGRAMME

REFERENCE TE 323

FINAL REPORT

SUBJECT OF STUDY:	HYDROLOGICAL FORECASTING - Observational Aspects -
U. N. FELLOW:	Sigurjon RIST
COUNTRY:	ICELAND
COUNTRY OF STUDY:	UNITED STATES
FELLOWSHIP:	23 AUGUST to 22 NOVEMBER, 1966 (3 months)

Denver, Colorado
18 November, 1966

C O N T E N T

NOMINATION

Reasons which led my Government to nominate me for a U. N. Fellowship:

1. Iceland will soon need river forecasting. To date, no attempts have been made at forecasting the flow of the rivers, but with the rapid growth of the Icelandic power industry, envisaged in the near future, the need for such forecasting will soon occur, since over 95% of the power is generated by hydro electric installations. Hydro-potential is one of the main natural resources of Iceland.

2. I was nominated for this U. N. Fellowship because I am in charge of hydrological observations and processing of the observational material at the State Electricity Authority (SEA) Hydrological Survey, which is the only agency in Iceland engaged in such observations. River forecasting is a new science; it was almost unknown when I studied hydrology 18 years ago, so I needed now to become familiar with basic principles and recent developments.

3. Stream-gaging recorders have been running for some years so we have collected enough stream flow basic data to start river forecasting trials without any delay.

TRAINING AUTHORITIES

My supervising authorities were members of the U. N. Bureau of Technical Assistance Operations in consultation with U. S. Government authorities in the International Education Exchange, Office of

International Health, Department of Health, Education, and Welfare.

My program schedule included training at the following agencies and places:

Pacific Power and Light Co., Portland, Oregon	Aug.24 - Sept. 2, 1966
Bonneville Power Administration Portland, Oregon	Sept.6 - Sept.16, 1966
U.S.G.S. Water Resources Div. Portland, Oregon	Sept.19 - Oct.14, 1966
State of California, Department of Water Resources Federal-State River Forecast Center, Sacramento, Calif.	Oct.17 - Nov. 4, 1966
Bureau of Reclamation and U. S. Geological Survey, Denver, Colo.	Nov.7 - Nov. 18, 1966

One day visits were arranged with the following agencies:

Soil Conservation, Portland, Oregon

Leupold & Stevens Instruments, Portland, Oregon

Corps of Engineers, Portland, Oregon

U. S. Weather Bureau, Portland, Oregon

Bonneville Dam, Laboratory, Columbia, Oregon

U.S.G.S. Glaciological Division, Tacoma, Washington (2 days)

Oreville Dam, California

Bureau of Reclamation, Sacramento, California

Federal-State Weather Bureau, Sacramento, California

Soil Conservation Service, Snow Survey, Fort Collins, Colorado

Colorado State University, Fort Collins, Colorado

The Kristi Snow Vehicles, Broomfield, Colorado

Goble, Sampson & Smith, Inc., Denver, Colorado

TRAINING PROCEDURE

The main lines in the training procedures were: conversation, demonstration, mathematical analysis on the blackboard, field trips for training and station arrangement, and reading assignments.

The firms, which are developing methods in river forecasting, gave me copies of their reports and booklets concerning that subject. In addition, I was generously supplied with publications covering all aspects of the hydrologic cycle.

Extract of My Diary:

Pacific Power and Light, Portland: General orientation. Bibliographical searching of the river forecasting regimen. How projecting engineers use hydrologic basic data in water supply projects. Field trip to study radio transmission of stream-flow data concerning river forecasting.

Bonneville Power Administration, Portland: River forecasting on seasonal, monthly, 10-day, daily, hourly basis, as a matter of fact, always from the view of power production.

U. S. Geological Survey, Portland: Duties comparable with those of the office I supervise in Iceland. I received an understanding of the whole organization, administration as well as new surveying methods. It was very profitable to learn about the highly developed organization of the daily work, from field data collecting to the publication stage.

Federal-State River Forecast Center, Sacramento: My studies there were mostly concerned about two related subjects:

1. rainfall - runoff forecast
2. flood routing

The River Forecast Center has developed a method of predicting the expected runoff, and peak discharge, for any given amount of rainfall over the basin, as well as any given basin moisture conditions. The development of the "Basin Model" has been, to a great extent, computerized so that many of the computations and steps are carried out automatically by the computer.

U. S. Public Health Service, Region VIII, Denver:

Bureau of Reclamation: I studied seasonal forecasting;
Effect of snow compaction on runoff;
Laboratory studies of groundwater movement;
Computerizing of hydrological data.

U. S. Geological Survey: I studied indirect measurements;
Radio transmission of data.

Soil Conservation Service: I studied administration of snow surveying.

SUGGESTION TO U. N. AND TRAINING AGENCIES

I can hardly imagine the training better arranged. There is only one suggestion I can make concerning the program. Each training agency should use some part of the time for a brief review of the study; it will avoid misunderstanding.

FUTURE RIVER FORECASTING IN ICELAND

Based on my local knowledge of the Icelandic conditions and what I have learned here in the U.S.A., I will mention the following items:

1. Seasonal forecasting: Most urgent is to undertake seasonal forecasting for rivers already utilized for hydroelectric power, and those where power plants are under construction.

   a. Low flow forecast for the entire winter should be made on December 1, and subsequently revised for the remaining months on each succeeding month, January 1, February 1, March 1, April 1, and May 1. (i.e. the rivers Thorsa, Laxa, Grimsa, Mjolka.)

   b. Low flow forecast for the entire summer should also be made on June 1, and revised each succeeding month, July 1, August 1, and September 1. (i.e. Laxa, Hunav.sysla)

   c. Then it is feasible to make river forecasting in rivers which will be developed in the near future.

   To make these forecasts, we need historic stream flow records to compare with other data collected during the same period. This would include meteorological records (precipitation, temperature, wind velocity, etc.), groundwater data, snow survey data, data on stages of the water level in lakes with no surface runoff, and the extent of frozen ground.

2. Forecast by ice effect: Forecast about extreme flow regression caused by ice formation. This type of forecast probably is unique for Iceland. When a cold spell starts, causing a

high rate of ice formation in the river channel, the discharge drops suddenly. Besides streamflow and meteorological data, we need one parameter more, a very effective one, that is the extent of open water in the river channel above the forecasting spot. Theoretically, the area of open water can either be measured each time or computed from previous analogous weather conditions; as an applied method, I can only recommend the latter. To get this forecast out early enough, it is necessary to use data from weather forecast.

3. Flood forecasts: Same type of forecast as RFC forecasts, which are described above. But, we need some more parameters related to Icelandic conditions. We must have parameter to indicate how great part of the basin surface is frozen and watertight. For a basin with poorly developed surface drainage system, we need parameter to indicate the volume of water collecting in depressions, which are watertight for a while, caused by frozen bottom.

SUGGESTIONS TO THE ICELANDIC GOVERNMENT

I advise the Government to take care of the new applied hydrological procedure - RIVER FORECASTING. The above enumeration is suggestive of our need. The procedure to develop the "forecast pattern" perhaps from as many as 10-30 components can, to a great

extent, be computerized and run easily on a computer. It is likely that there we will have no problem. But, we must pay attention to the fact that no forecast can be more accurate than the data it is based on. Therefore, we must be both active and conscientious in collecting basic data of wide range for use in correlation analysis.

In the following are some proposals to improve our situation. I have in mind our local conditions and experience which I got as a U. N. fellow.

1. Stream gaging

   a. Further extension of our stream gaging network is necessary. The report, which (SEA) Hydrological Survey (Vatnamaelingar) issued some years ago, containing a schedule for development of our stream gaging network during the period 1962-1968, can be used as a basis for further discussion and review.

   b. We need radio communication systems for transmission of water level information from remote places to the office, especially needed in forecasting of future river flow.

      I suggest that as soon as possible, we install one or two radio operated water level recorders and also one or two telephone operated recorders. When we have experience, we intend to install at least 6 units. Six rationally located radio transmitting stations will

describe, fairly clearly in the office, what is going on in the field in each part of the country.

c. Automation of stream gaging needs to be studied in detail from an economical viewpoint by the Hydrological Survey.

2. Snow Surveying

a. Snow Surveying should be made for the whole country.

b. The Hydrological Survey (Vatnamaelingar) should be the main center and should be prepared to give instruction. They may also cover to measure snow in the inland and prepare data for publication.

169, 425 - 171, MHz

c. It is very important to get other agencies working on these subjects. At present, only the Hydrological Survey and Weather Bureau are equipped to do so.

Snow survey measurements should be made at the end of each winter month. Therefore, it would be most economical to assign this work, in the coastal ranges, to local employees of state agencies on a one-day-a-month basis. Such assignments could be handled by government authorities.

Two-man teams could be assigned for the following agencies:

Hydro power plants: their basin

Forestry: Vaglaskogur, Hallormstadaskogur, Skaftafell, Borgarfjordur

Road Department: Hellisheidi, Holtavorduheidi,
Thorskafjardar or Steingrimsfjardarheidi,
Bru-Modrudaluf, Oddsskard

Agricultural School Holar: Hjaltadalur

Akureyri's Water Supply Board (municipal): Hlidarfjall

3. Groundwater:

a. We need an extension of our groundwater network in connection with river forecasting. I suggest that, as a first step, we install and run 10 or 12 groundwater recorders in wells, test drill holes and in lakes without any surface runoff.

b. Groundwater data needs to be collected and published in order to be of value in our forecast studies. Some governmental and municipal agencies have maintained local groundwater levels measurements, mostly in drill holes. It is of great importance to collect all this data at one groundwater center. It makes no difference whether it concerns "hot" or "cold" groundwater, but it must be carefully indicated if water level stage was subject to outside influences such as pumping or artificial recharge.

If this data is available at any time, it can have value as historic data for river forecasting.

4. Meteorological data:

The meteorological data are very important factors in river forecasting. For example, historic precipitation records correlated to runoff determines the runoff "pattern" for a river basin. By assuming that this "pattern" will not change in the near future, it may be used to predict runoff. Therefore, we need stable stations and continuous records. If a station is affected by any alternation, new equipment is installed, or observation undertaken at a new place, the older station should be kept in operation for a while for overlapping of records.

We can divide the meteorological data which are needed in river forecasting into two parts:

a. Historic data (publications)
b. Current data, which must be available with a minimum of delay.

I do not consider myself able to make realistic suggestions about the collection of meteorological data or cooperation between Iceland Weather Bureau and SEA-Hydrological Survey about this subject. It is, therefore, my proposal that these agencies cooperate to analyse the factors concerning river forecasting and give a report to the government.

On my return home, I will, through my bureau, make this statement clear to the Director of the Iceland Weather Bureau.

ACKNOWLEDGEMENT

As I am leaving the host country, it is clear to me that I have gotten a lot of valuable information during these three months. I hope I will be able to put this information to use to increase the efficient development of hydrological investigations in my home country.

I wish to give my best thanks to the Icelandic Government for my nomination; U. N. Bureau of Technical Assistance Operations for my fellowship and supervision of my training; and to the U. S. Government for arranging my training programme and supervising the study. A special thanks to Mr. Jakob Gislason, Government Project Representative, Reykjavik; to Mrs. Margaret J. Rukavina-Shoukletovich, Chief of the Training and Fellowship Programmes Section, United Nations, New York; and to Mr. William S. Wilson, Program Director, International Education Exchange, Office of International Health, Washington, D. C., for all their help and supervision. And, I am very grateful to all the many agencies which I have visited and I am very thankful to all the many persons whom I met and made my staying ever memorable.

Denver, Colorado
18 November, 1966

Sigurjon Rist

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Technische Daten

Doppelte gegenläufige 90°-Winkelteilung.

Nonius mit einer Ablesegenauigkeit von ± 0,1° (Schätzung 0,05°).

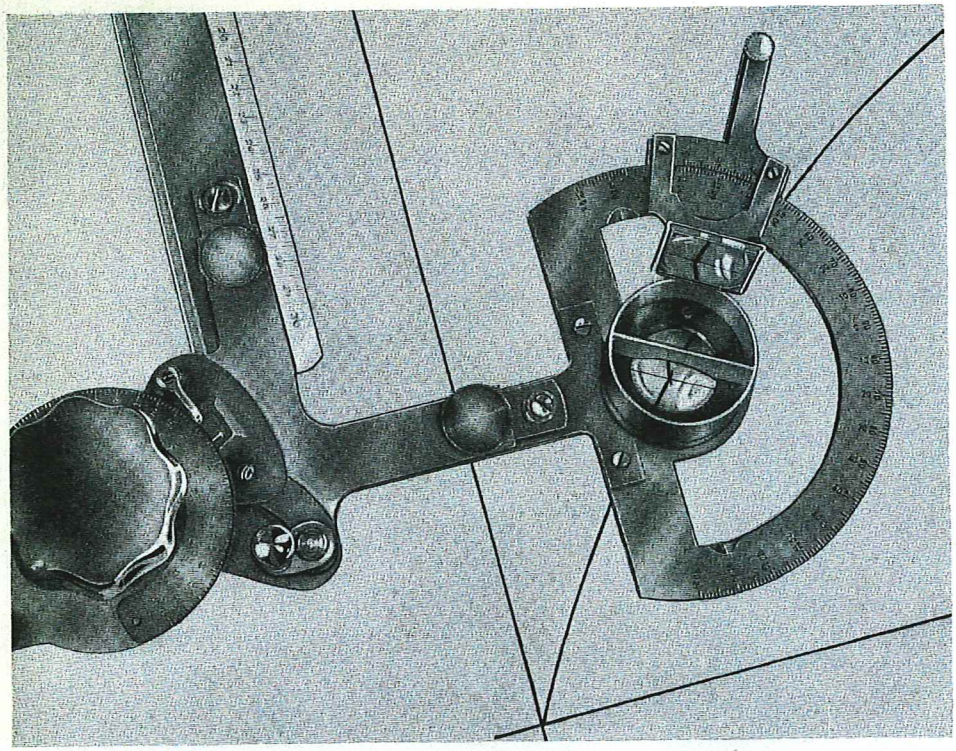

Abb. 2

Derivimeter zum Anlegen an eine Reißschiene Nr. 332

Kennwort *Gojag* (Abb. 1)

Gewicht: ohne Etui 0,50 kg,
mit Etui 0,86 kg.

Größe des Etuis 208 x 186 x 50 mm.

Derivimeter zum Ansetzen an eine Zeichenmaschine Nr. 334

Kennwort *Gojok* (Abb. 2)

Gewicht: ohne Etui 0,54 kg,
mit Etui 0,90 kg.

Größe des Etuis 208 x 186 x 50 mm.

Bei der Bestellung, ist die Firma und das Modell der Zeichenmaschine anzugeben oder das Anschlußstück eines Lineals einzusenden.

Wir bitten, bei Rückfragen die Fabrikationsnummer des gelieferten Instrumentes anzugeben.

Änderungen im Sinne des technischen Fortschrittes vorbehalten.

A. OTT
GMBH
FABRIK FÜR FEINMECHANISCHE INSTRUMENTE UND PRÄZISIONSMASCHINEN
8960 KEMPTEN/BAYERN
Mozartstraße 18–20

DERIVIMETER

Verwendungszweck

Bestimmung des **Neigungswinkels** der **Tangente** in einem Punkt einer als Kurvenzug gegebenen Funktion.

Dem Tangens dieses Winkels ist der erste **Differentialquotient** direkt proportional.

Auf eine entsprechend große Anzahl von Punkten angewandt, ermöglicht dieses Verfahren die **punktweise Aufzeichnung der Differentialkurve.**

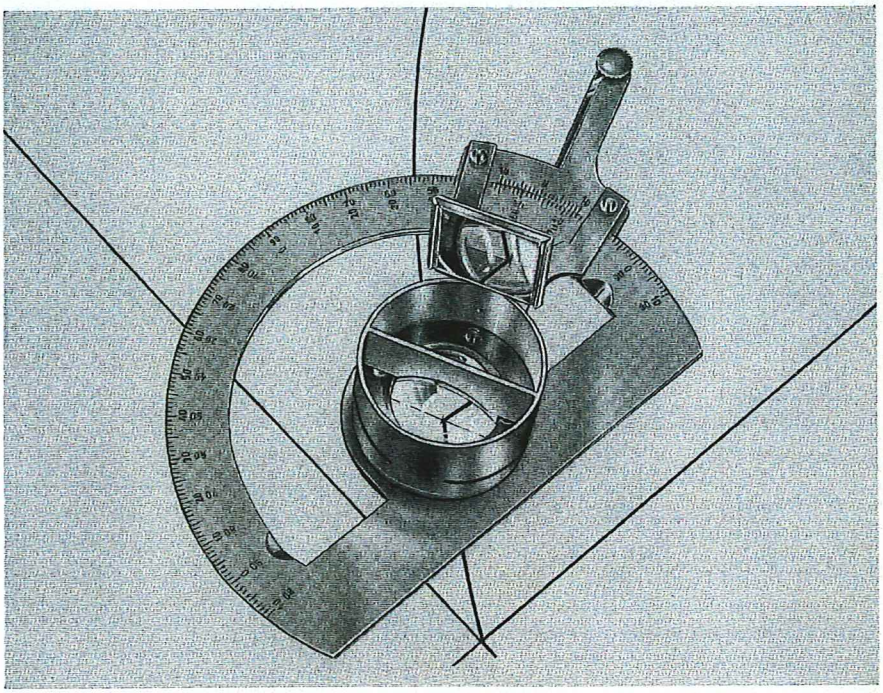

Abb. 1

Wirkungsweise

Wird ein Spiegel senkrecht zur Zeichenebene über einen Punkt einer Kurve gestellt, so geht die Kurve nur dann ohne Knick in ihr Spiegelbild über, wenn die Ebene des Spiegels normal zur Kurventangente in diesem Punkt steht.

Beim OTT-Derivimeter wird als spiegelnde Fläche die Berührungsebene zweier Lupenhälften benützt. Dies hat den Vorteil, daß das eintretende und das austretende Kurvenstück gleichzeitig beobachtet werden können, was eine besonders genaue Einstellung des Instrumentes bei stark gekrümmten Kurven gestattet.

Die Lupe ist im Mittelpunkt eines Winkelmessers auf einem drehbaren Arm angebracht.

Der Tangenswert zu dem abgelesenen Winkel wird einer dem Instrument beigegebenen Tabelle entnommen.

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